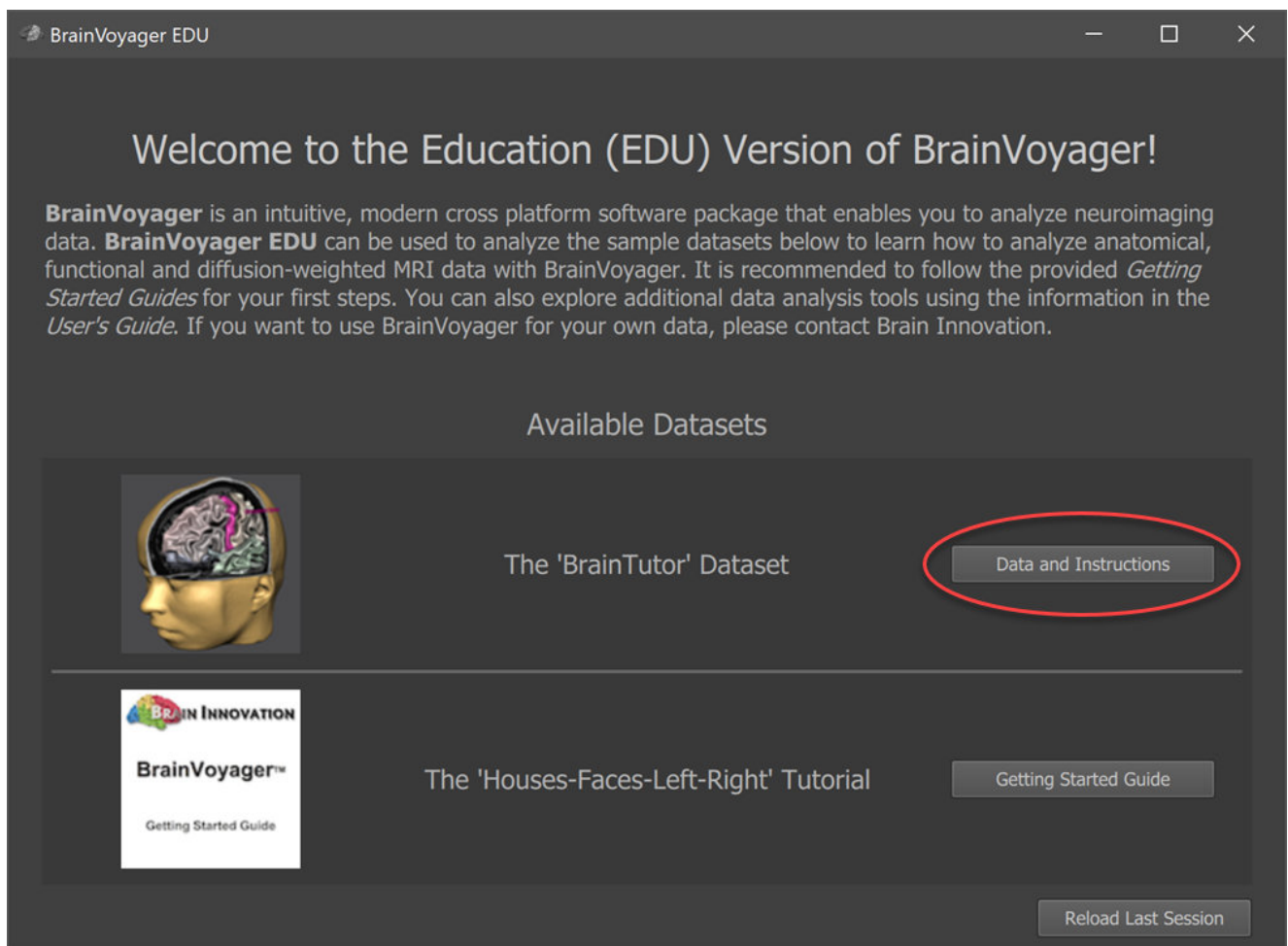


Basic Visualizations using Brain Tutor Data

In this guide you will learn about basic visualization capabilities of BrainVoyager and BrainVoyager EDU. You will learn how to load and browse through 3D anatomical datasets and how to load and view head and cortex mesh files that have been prepared using BrainVoyager tools. In case you want to learn how to create volume and mesh files from raw scanner data yourself, follow the instructions in the Getting Started Guide (GSG). In the EDU version, the GSG as well as this guide can be chosen from the **Welcome** overview screen (see screenshot below). In BrainVoyager, the guide can be found in the *GettingStartedGuides* folder located in the *BrainVoyager installation folder*. For general background information about the capabilities of BrainVoyager, consult the *User's Guide* that is available in the **Main Toolbar** and the **Help** menu.

First Steps

After starting BrainVoyager EDU, select the 'The BrainTutor Dataset' in the appearing **Welcome** screen by clicking the **Data and Instructions** button (see screenshot below).



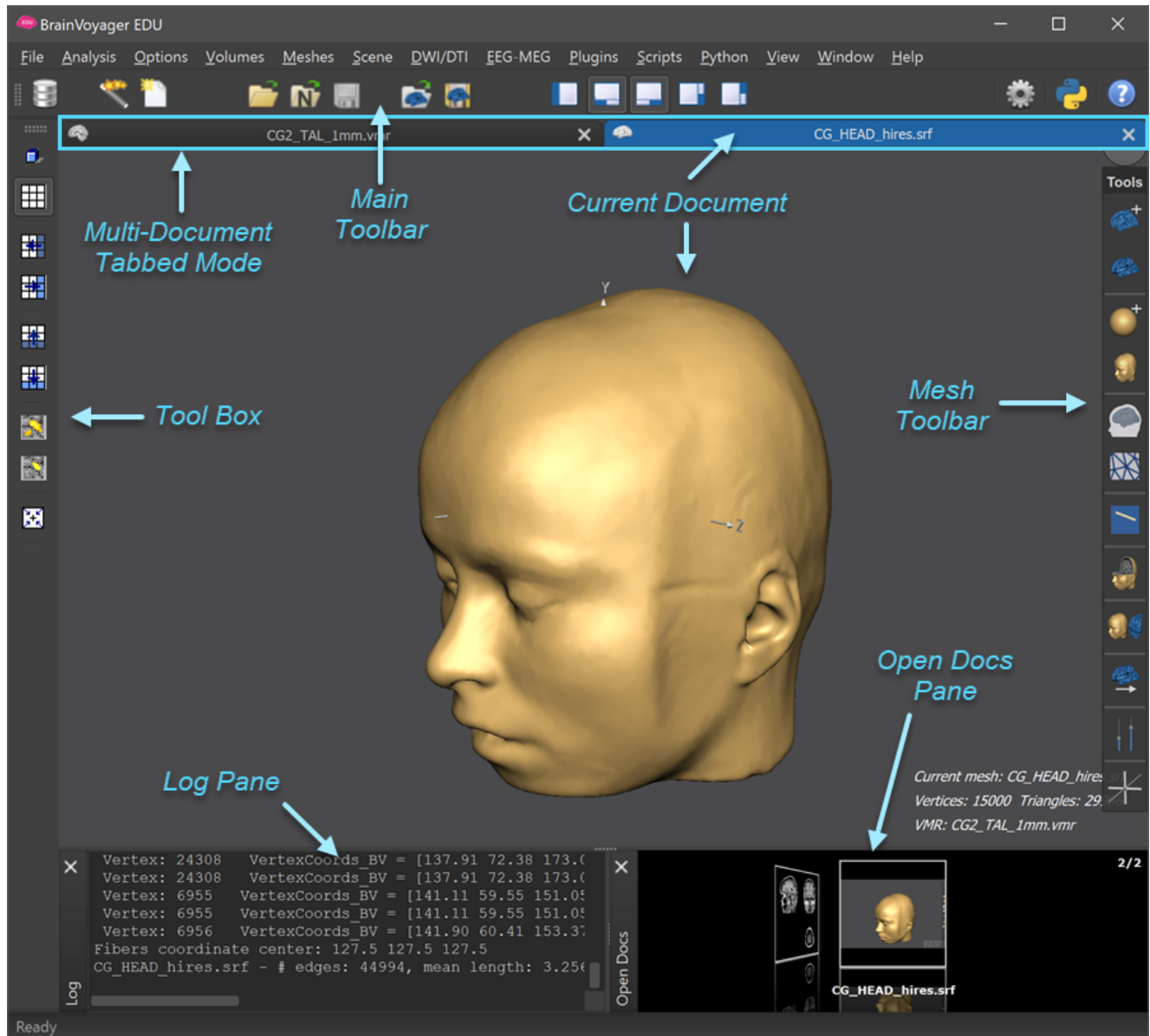
This will load a 3D anatomical dataset from your disk called "CG2 TAL 1mm.vmr" and a head mesh file called "CG head hires.srf". In case the data is not available on your computer, the program offers to download them from our web site (<https://www.brainvoyager.com/bv/sampleddata/index.html>) where you can also manually download them. The data and this guide are downloaded as two ZIP files into your

Documents/BVSampleData folder. After downloading is complete, the ZIP file containing the data will be extracted into the /Documents/BVSampleData/BrainTutorData folder while the PDF guide itself will be placed in the /Documents/BVSampleData folder.

When the data is downloaded and installed, the 3D anatomical dataset "CG2 TAL 1mm.vmr" and the head mesh "CG head hires.srf" will be automatically loaded but you can also load them manually using the **Open** icon and the **Load Mesh** icon in the **main toolbar** of the program. Note that each of these two datasets are visualized inside their own tab in the [multi-document interface](#) (MDI) - the central part of the program window.

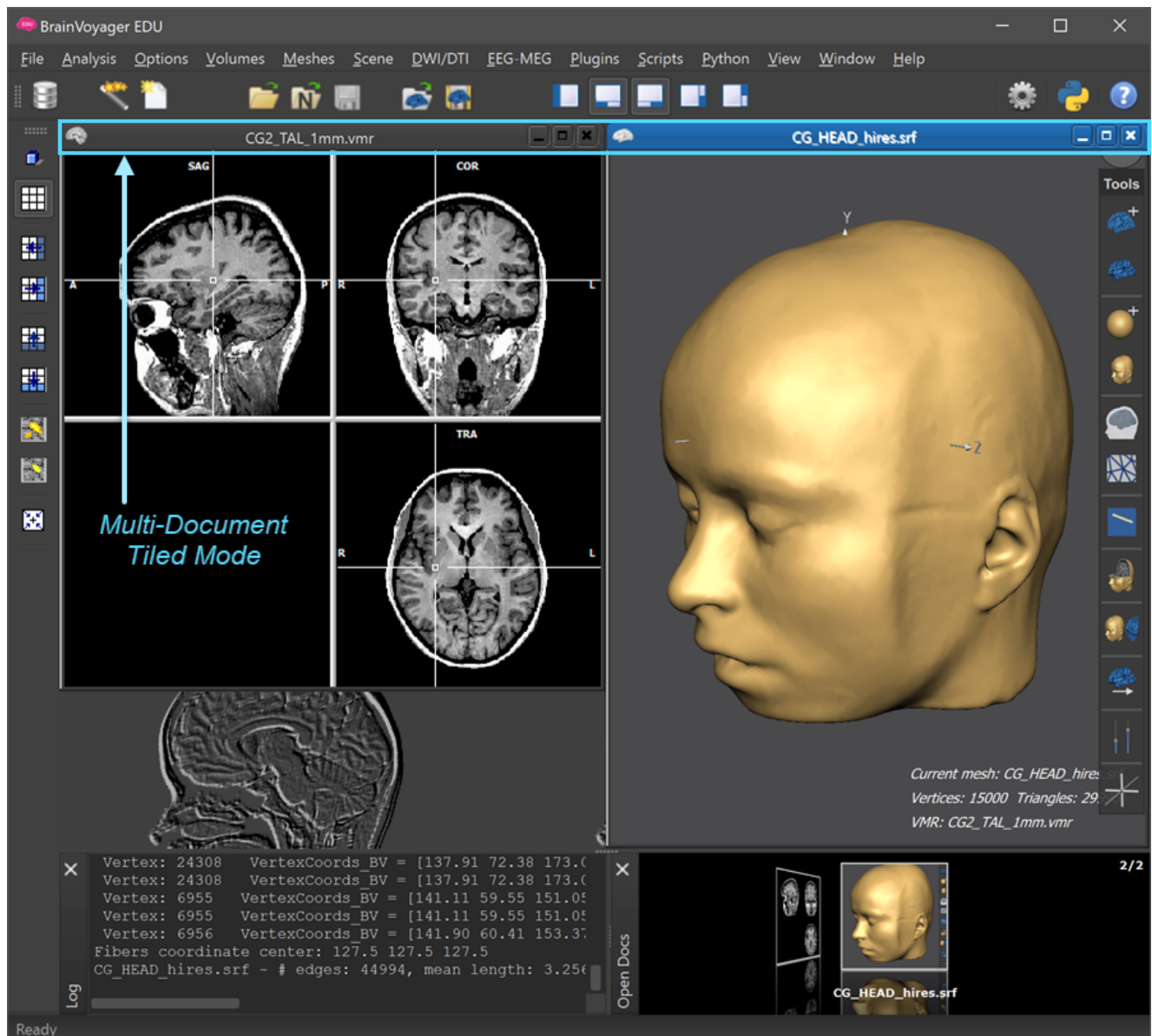
The Multi-Document Interface

The **Multi-Document Interface** (MDI) covers the central area of BrainVoyager's graphical user interface (GUI) containing a workspace for multiple documents, each represented by a document window. Document windows can be presented in *tabbed mode* with only one document visible at a time (like in a modern web browser) or in *tiled mode* showing multiple document windows simultaneously,



The screenshot above shows the MDI area in tabbed mode (default) with one of two documents (a cortical mesh window) covering the whole MDI area space. To switch between documents in the workspace, click on the respective document's window title inside the tab bar at the top of the MDI area (see blue arrow on the left upper side). Note that the document selected in the tab bar is called the *current document* since operations will be applied usually to the selected document. Operations are executed using the main menu as well as the main toolbar among others as described in the 'Getting Started Guide' and the 'User's Guide'. Working with documents in the central workspace area is further facilitated by *toolbars* and *panes* providing important functionality and information. The screenshot above shows the **Main Toolbar** on top of the window, the **Tool Box** on the left edge and the **Mesh Toolbar** on the right edge. The bottom section shows two panes, the **Log Pane** showing important general information and the **Open Docs**

Pane presenting all documents in the MDI area with small thumbnails that can also be used to switch between documents by clicking the respective visual representation.



If you want to see multiple documents at the same time, you can switch into tiled mode using the **Tile** item in the **Window** menu. The screenshot above shows our two automatically loaded documents side by side in the MDI area. In tiled (sub-window view) mode, you can freely position the document windows inside the MDI area and you can use the operating system resizing options to change the space occupied by each sub-window.

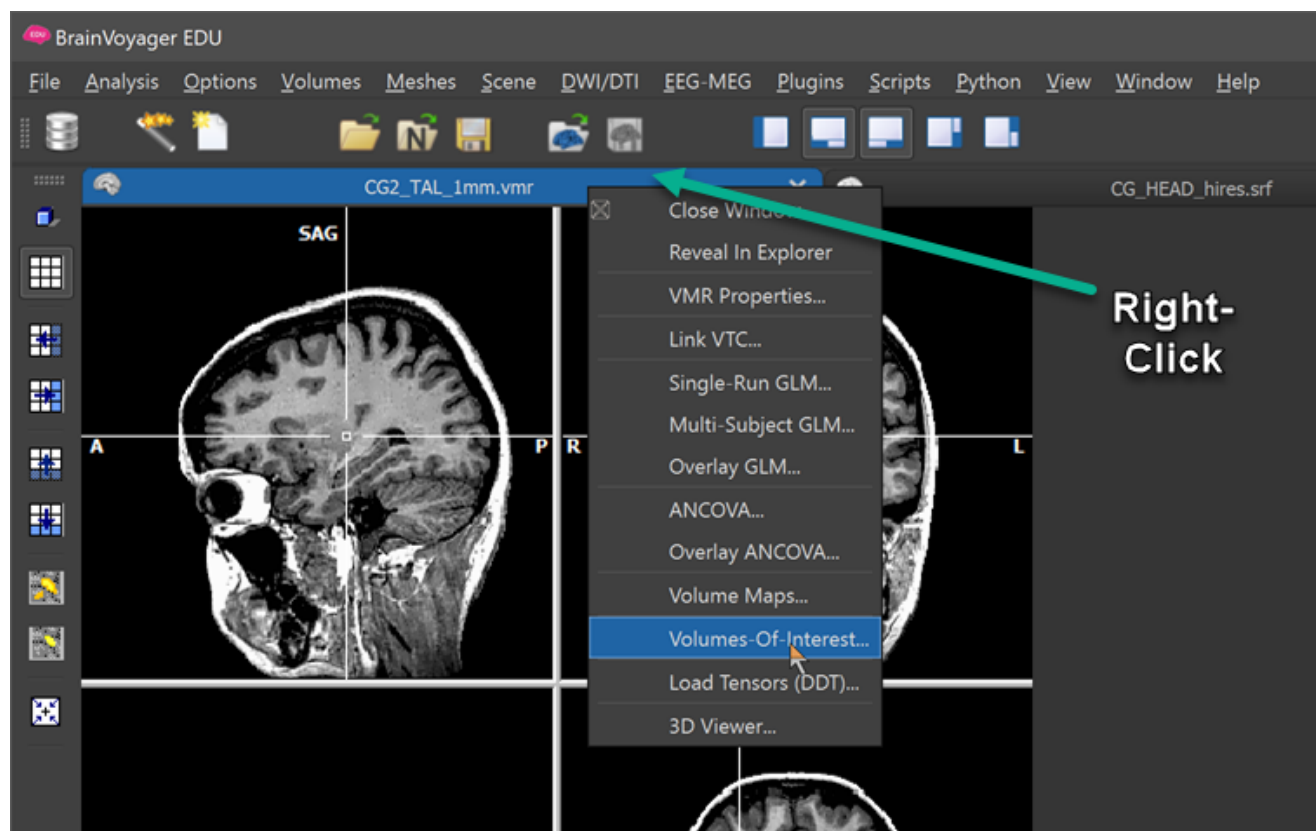
Opening Documents

In order to open functional, anatomical and diffusion-weighted documents, the **Open Document** icon in the main toolbar, the **Open** item in the **File** menu or the CTRL+O (CMD+O on macOS) keyboard shortcut can be used. To open a NIfTI file, the **Open NIfTI** item in the **File** menu or the SHIFT+F keyboard shortcut can be used. These actions will call a standard **File Open** dialog in BrainVoyager's current directory, which can be used to select an existing file in the presented directory or in any other directory that can be reached by using standard directory tree navigation commands.

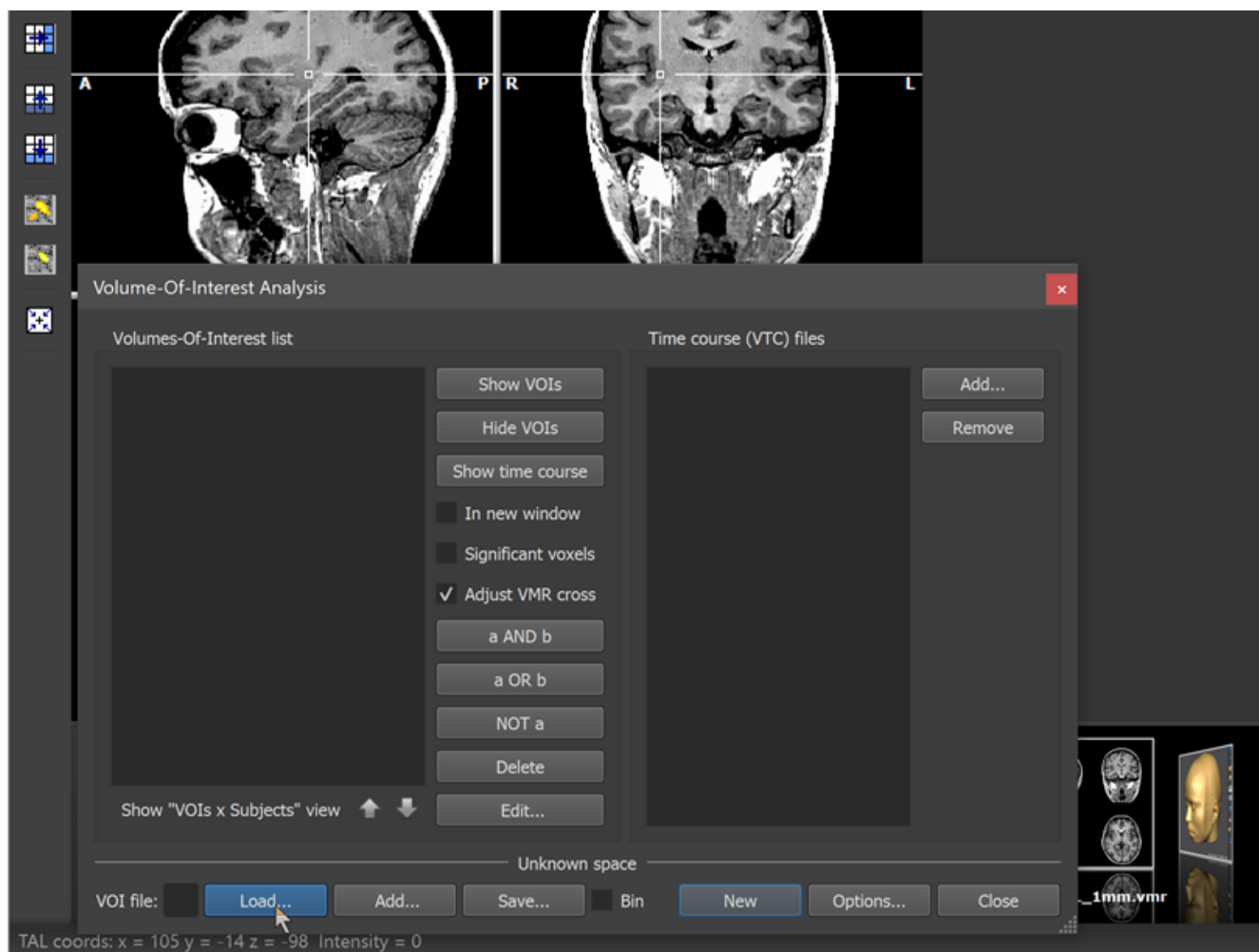
Go now back to tabbed mode and make the 3D anatomical (VMR) dataset the current document since we will use that document in the next topic.

Volumes-Of-Interest

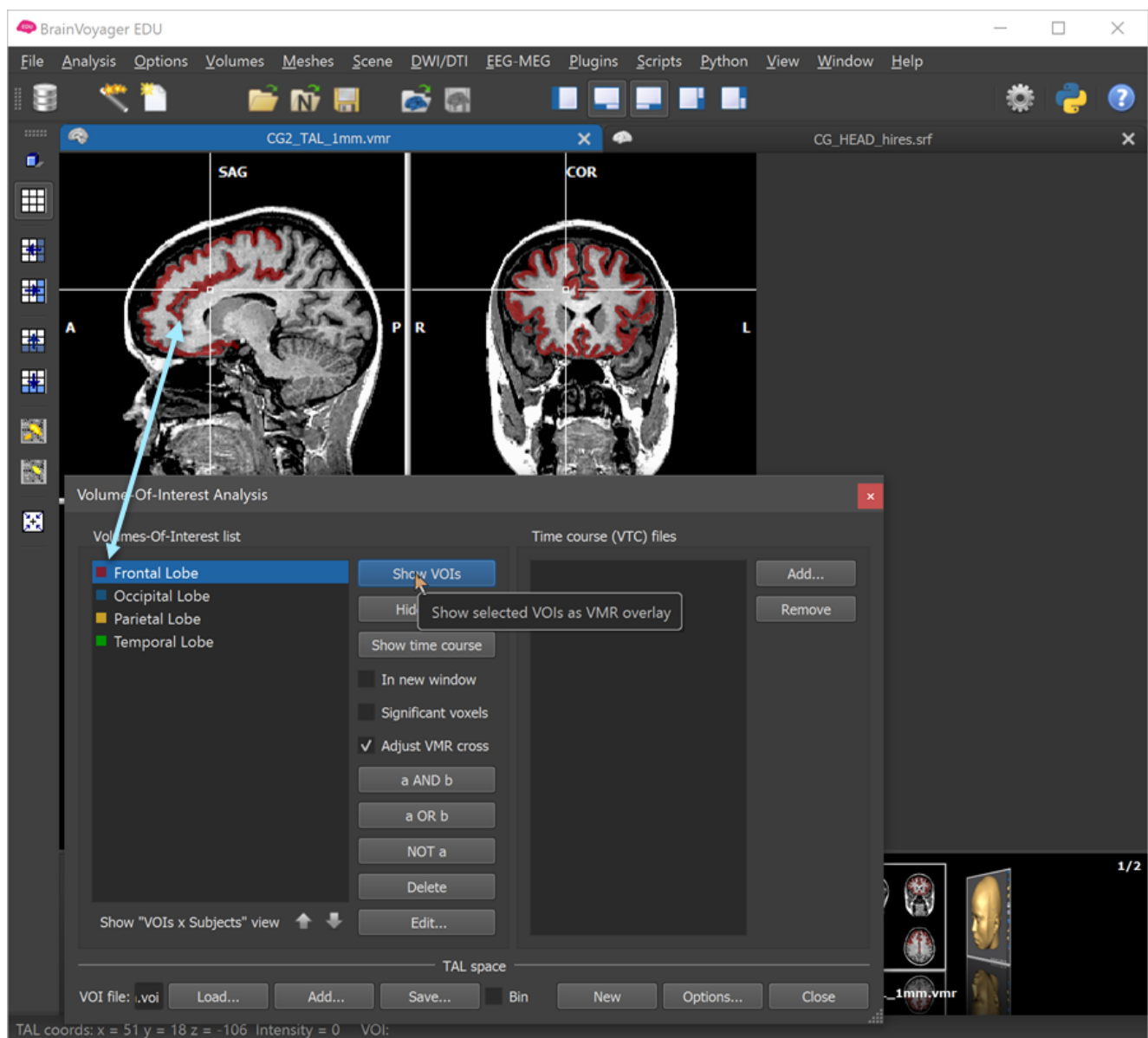
Regions-of-Interest (abbreviated as 'ROIs') play an important role in neuroimaging supporting multiple functions including ROI-based statistics, segmentations, atlases, brain parcellation schemes and many more. In BrainVoyager, ROIs are both supported in volume space as *Volumes-Of-Interest* (abbreviated as 'VOIs') as well as in surface space as *Patches-Of-Interest* (abbreviated as 'POIs'). In this tutorial we explore the role of VOIs and POIs in the context of simple brain atlases that are used in the desktop and mobile versions of the 'Brain Tutor' app.



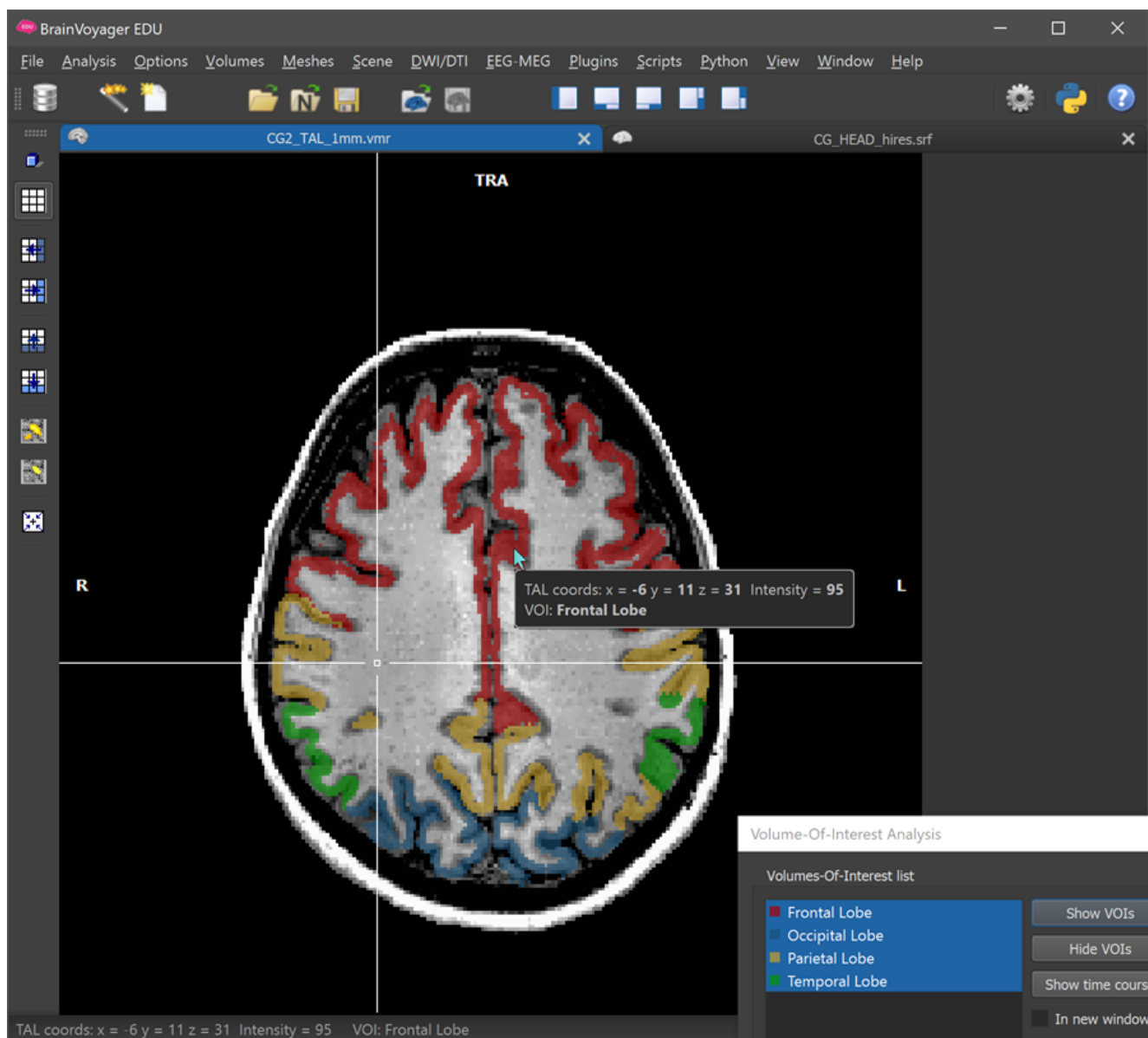
For this part of the tutorial, please make sure that the VMR document is the current one in the MDI area. If the document is not loaded, open the `CG2_TAL_1mm.vmr` file from the `BrainTutorData` folder. Now open the `Volumes-Of-Interest Analysis` dialog, e.g. by selecting `Volumes-Of-Interest` in the local (title bar) menu of the VMR document window. Alternatively you can use the `Region-Of-Interest Analysis` entry in the `Analysis` main menu or use the CTRL-R keyboard shortcut.



In order to open a VOI file containing a brain parcellation, click the **Load** button in the displayed **Volumes-Of-Interest Analysis** dialog (see above) and select the **Lobes_LHRH_bin.voi** file in the **BrainTutorData** folder. After opening the file, the **Volumes-Of-Interest list** will be filled with all the names of the regions stored in the file. In order to visualize the corresponding region in the VMR dataset, select one or more items in the list and then click the **Show VOIs** button (see below).



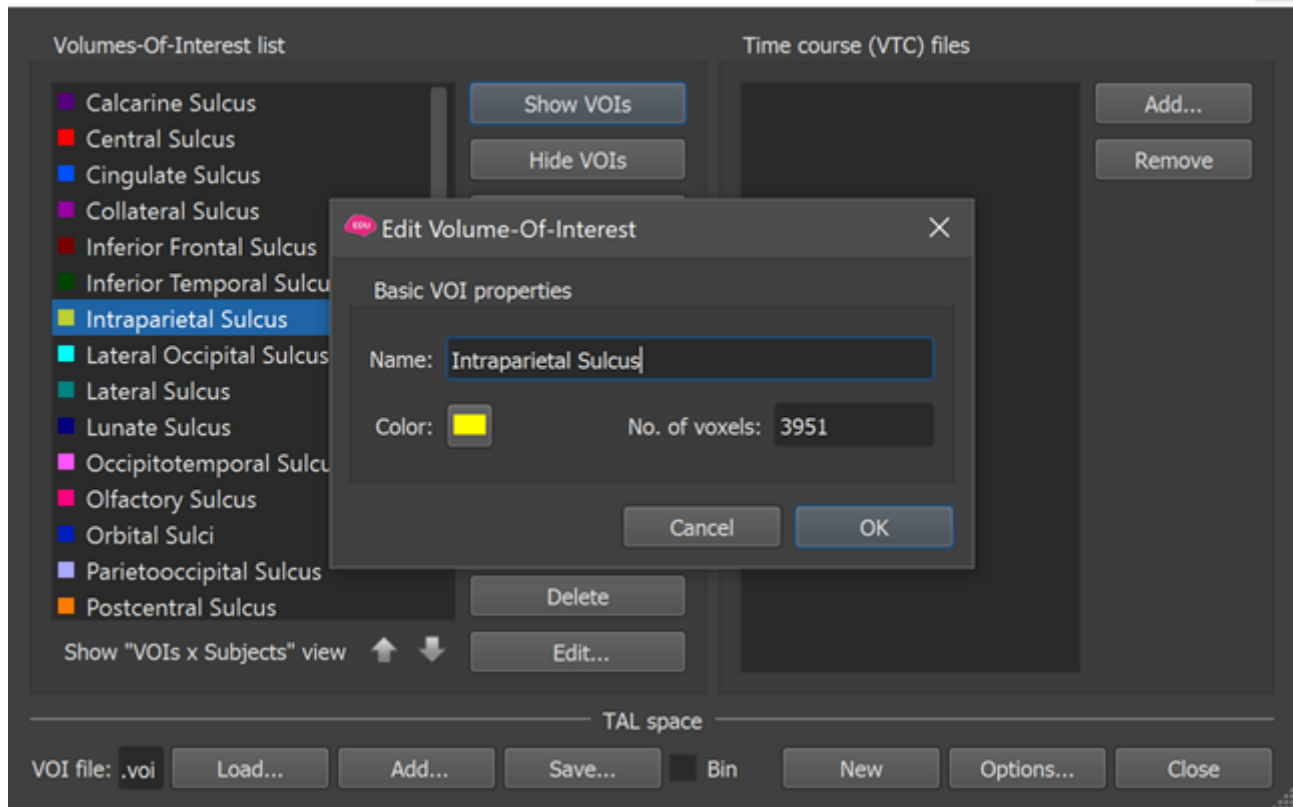
In the screenshot above the first list entry 'Frontal Lobe' has been selected; after clicking the Show VOIs button, the voxels in the VMR dataset corresponding to that region are marked with a color that is indicated at the left side of the list text entry (red in the example). You can explore the marked region by clicking inside one of the orthographic view sub-windows and by moving the mouse while holding the left mouse button down. While moving the location within one orthographic slice view, the other two views will adjust the slice plane accordingly.



As an exercise, show all 4 lobes in the VMR dataset in a similar way as indicated above. Note that you can change the VMR window display from showing all orthographic views (default) and displaying an enlarged view of a single **SAG**, **COR** or **TRA** plane by pressing repeatedly the CTRL-T keyboard shortcut.

Tip. When hovering (not clicking) the mouse over voxels in the VMR view, a small window will be displayed with information about the coordinate of the voxel under the mouse cursor; in case that the mouse hovers over a color-coded VOI voxel, the name of the corresponding VOI is also displayed in that tool window (e.g. VOI: Frontal Lobe in the screenshot above).

To practise using the VOIs, load another VOI file from the 'BrainTutorData' folder and explore the defined brain parcellations for gyri, sulci and subcortical structures. You may also change the name and color of individual VOIs using the **Edit** button in the **Volumes-Of-Interest Analysis** dialog. The appearing **Edit Volume-Of-Interest** dialog (see below) contains basic properties of the selected VOI such as its name, color and number of voxels defining its region.

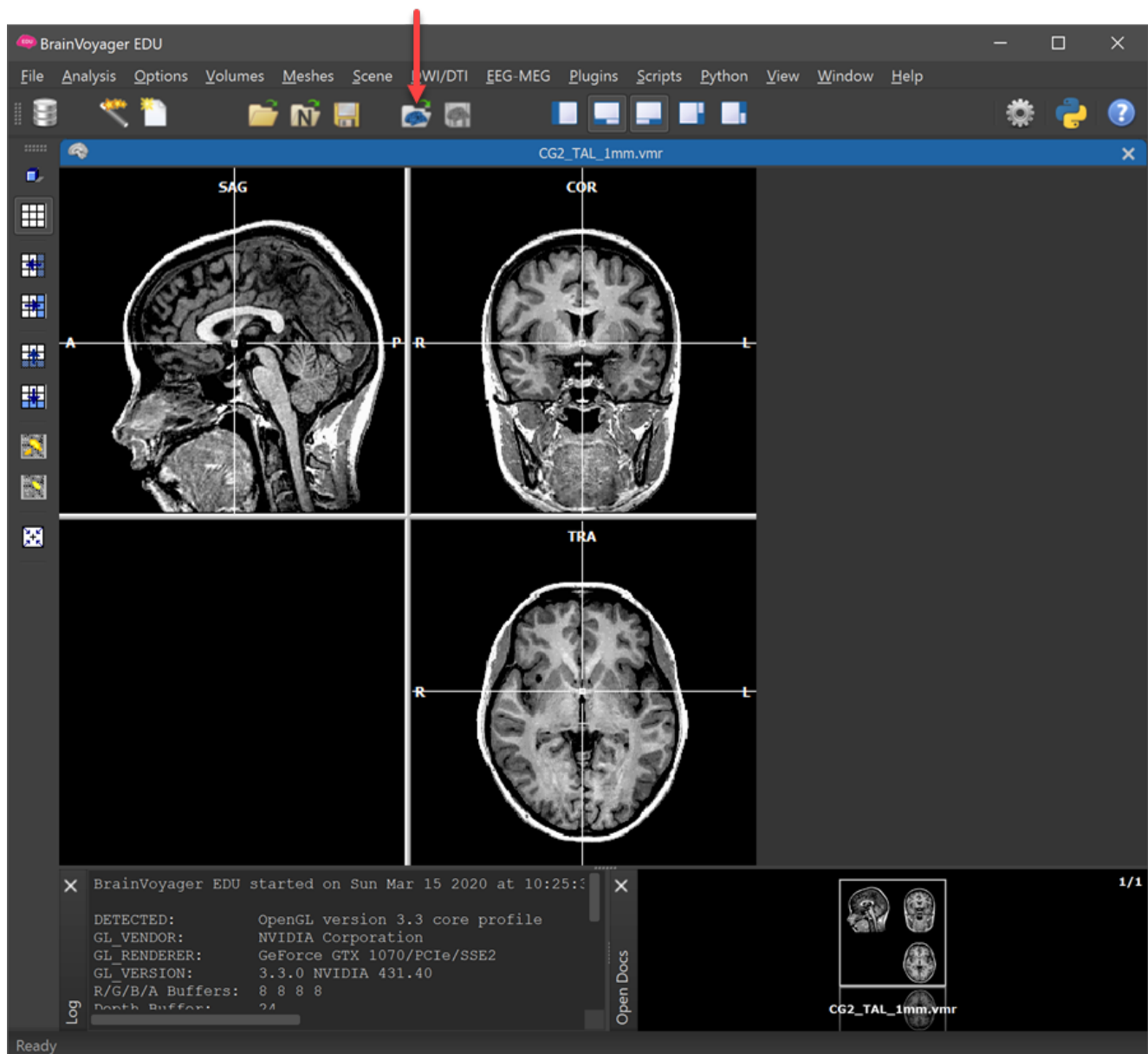


The 3D Viewer

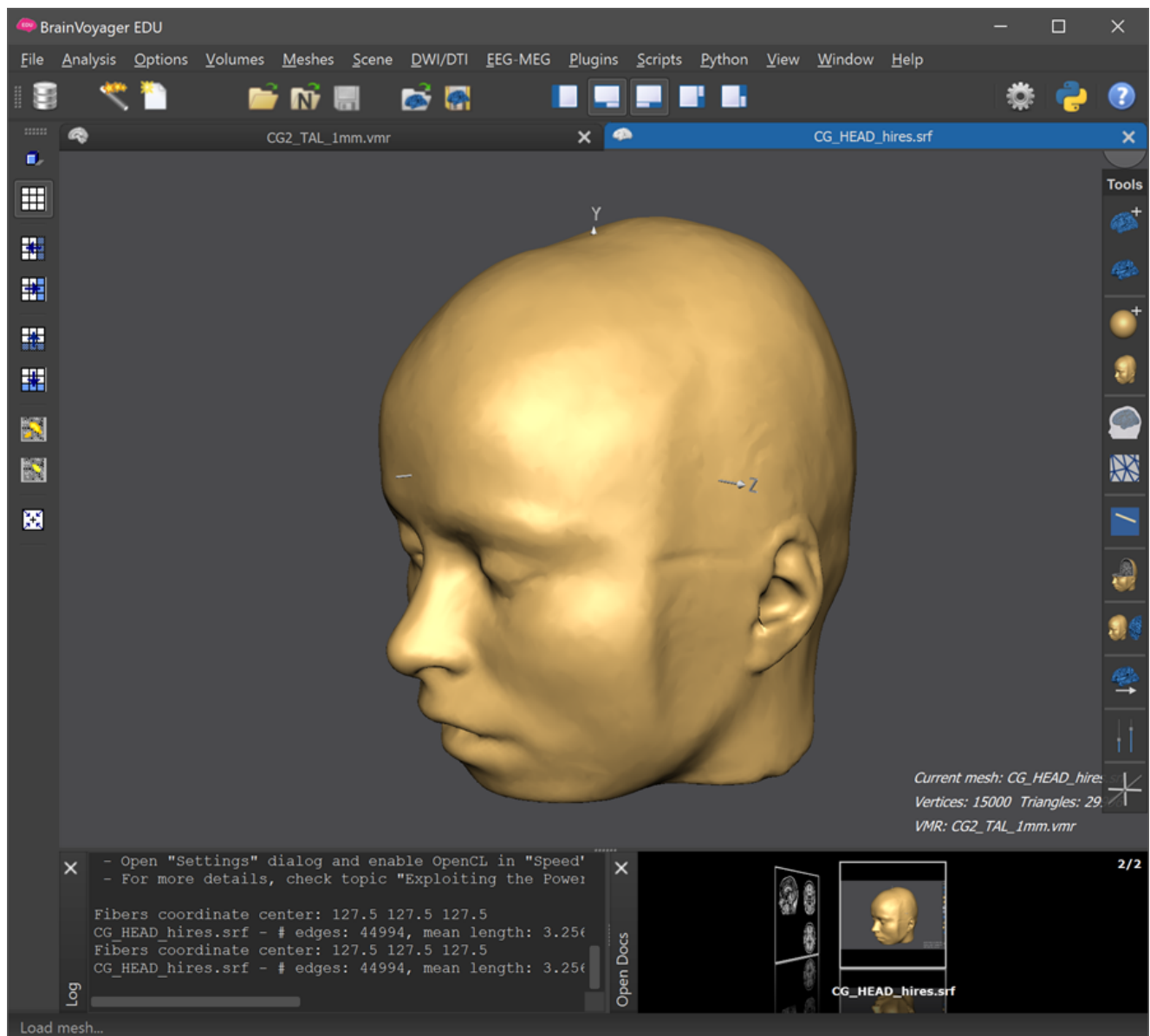
The previous topics have shown how slice-based MR imaging (VMR) documents can be opened from disk. For advanced data analysis and visualization, BrainVoyager supports the creation and processing of mesh (surface) documents that are manipulated in the `3D Viewer window` - or `3D Viewer` for short. A `3D Viewer` can be used to open and visualize one or more mesh (SRF) documents. Since meshes are usually derived from 3D anatomical (VMR) data sets, a 3D viewer can only be opened when at least one VMR document window is available in the multi-document area. In case that a VMR document window is the currently active document, a `3D Viewer` can be launched and will be associated with the currently active VMR document window and vice versa. This link extends from the respective windows to the contained documents, i.e. any mesh loaded or created in the 3D Viewer is automatically linked to the anatomical VMR document in the associated document window. The established link allows many useful analysis and visualization scenarios that are described in the User's Guide such as creating a head mesh and reconstructing a cortex mesh from a segmented VMR dataset.

Opening a Mesh Document

In this tutorial, a head mesh is made available that was created with BrainVoyager. The `CG head hires.srf` file is automatically loaded when selecting this tutorial. To practice opening a mesh file, click the `Close` icon on the right upper corner of the document window containing the mesh (if loaded). Make sure that only the VMR dataset is available in the MDI window as shown below.

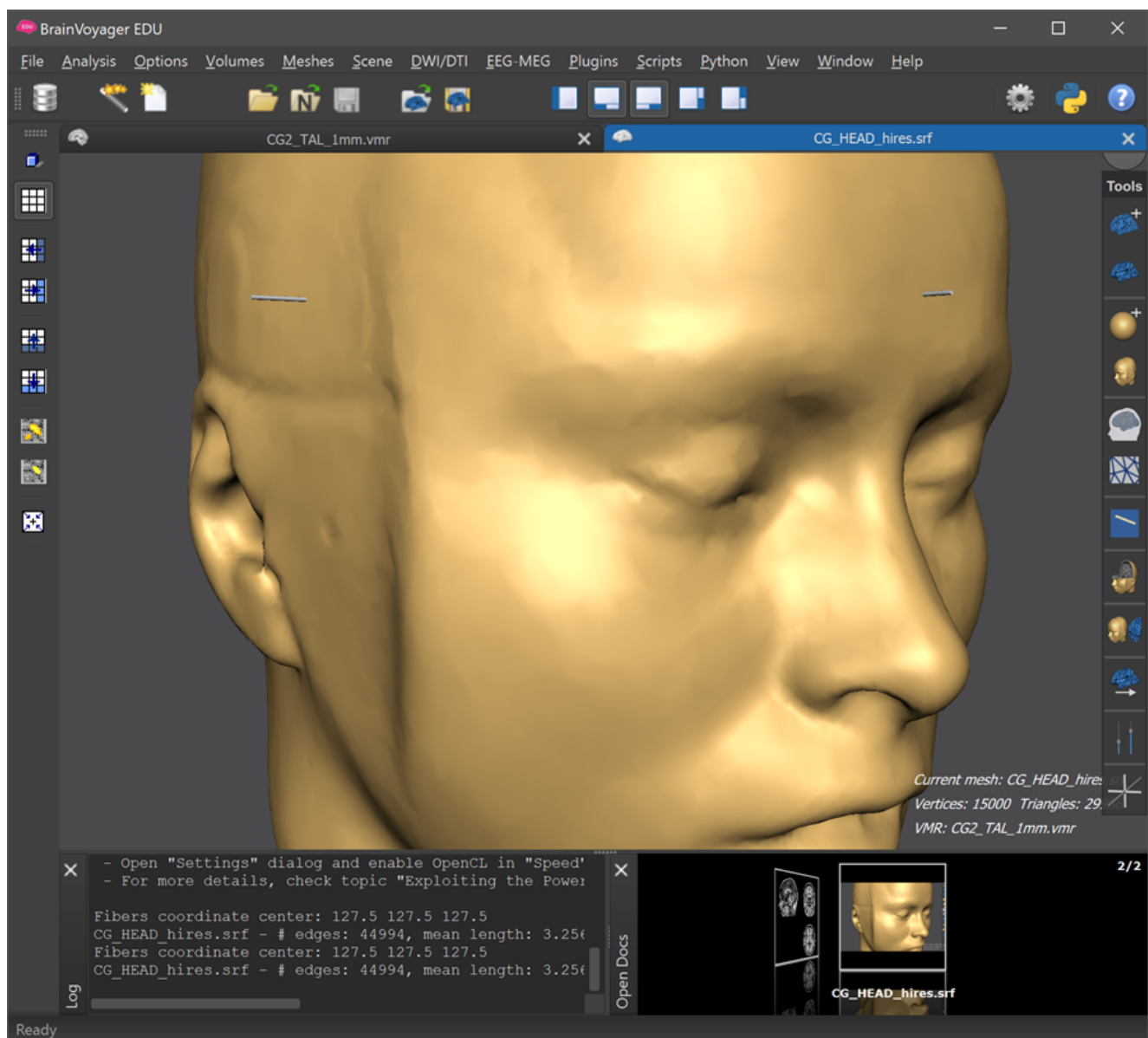


Now click the **Load Mesh** icon as shown above (or click the **Load Mesh** item in the **Meshes** menu) and select the **CG head hires.srf** item in the appearing **File Open** dialog. This action will create an empty **3D Viewer** window displaying the selected head mesh as shown below.



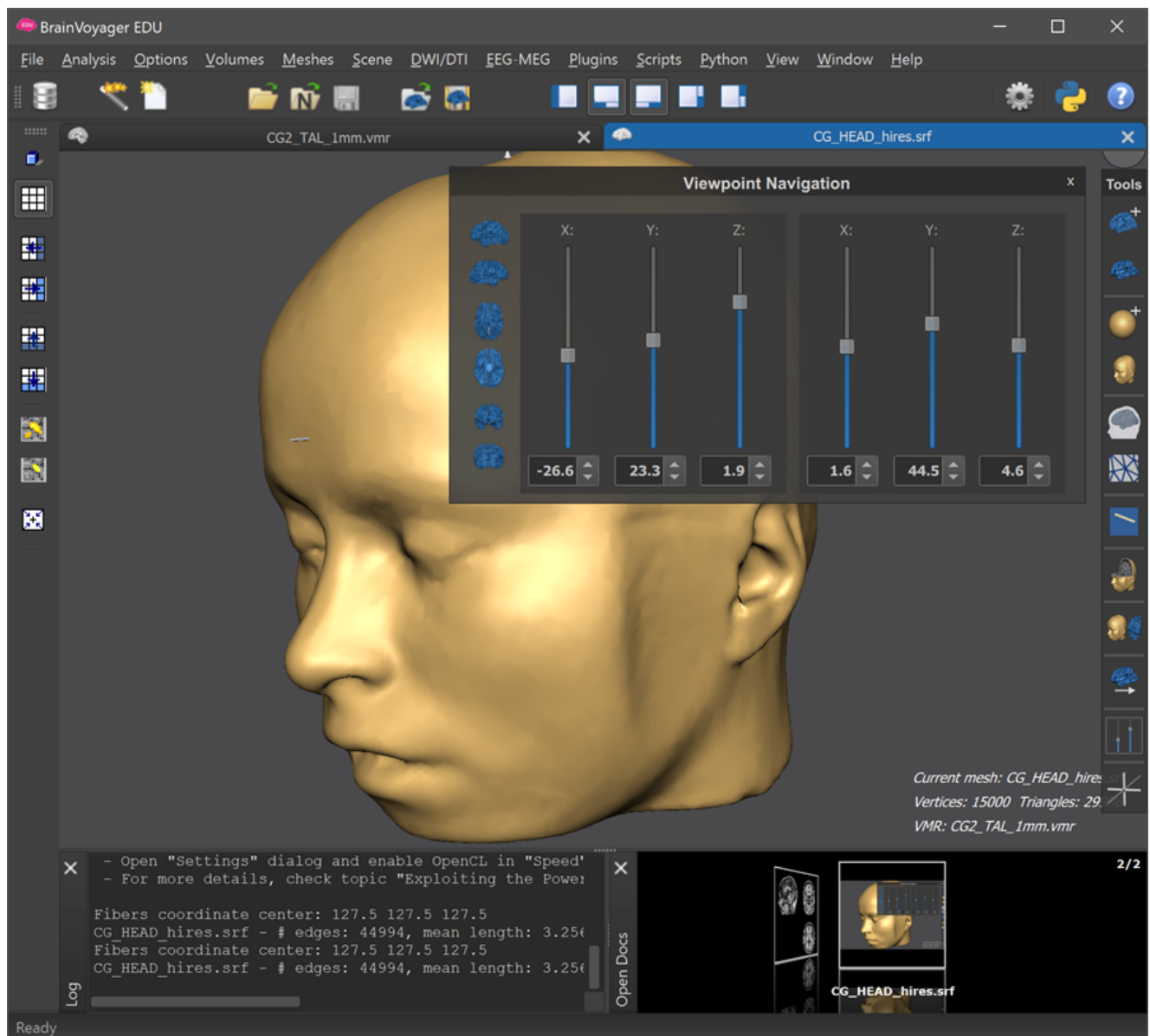
Viewpoint Navigation

Now click inside the mesh window, hold the mouse down and move it left / right and up / down - you will see that the mesh rotates around of specific coordinate axes. If you move the mouse while holding down the right mouse button, the mesh will be moved (displaced) along different coordinate axes. If you hold down both mouse buttons simultaneously while moving the mouse up or down, the mesh will move closer towards you or further away (see below). These rotations and translations are actually affecting the position and orientation of the stage on which meshes are placed. Note that all meshes on the [Stage](#), can be manipulated not only by mouse movements but also by using keyboard actions, or by using fingers on a touch screen or track pad - for details consult the User's Guide.



Note. Viewpoint changes are not (usually) moving the camera (that records the scene) but they manipulate the position and orientation of the **Stage** while the camera stays at a fixed position. This approach enables constant lighting (coming from the camera position as default) and a clear and consistent way to rotate meshes.

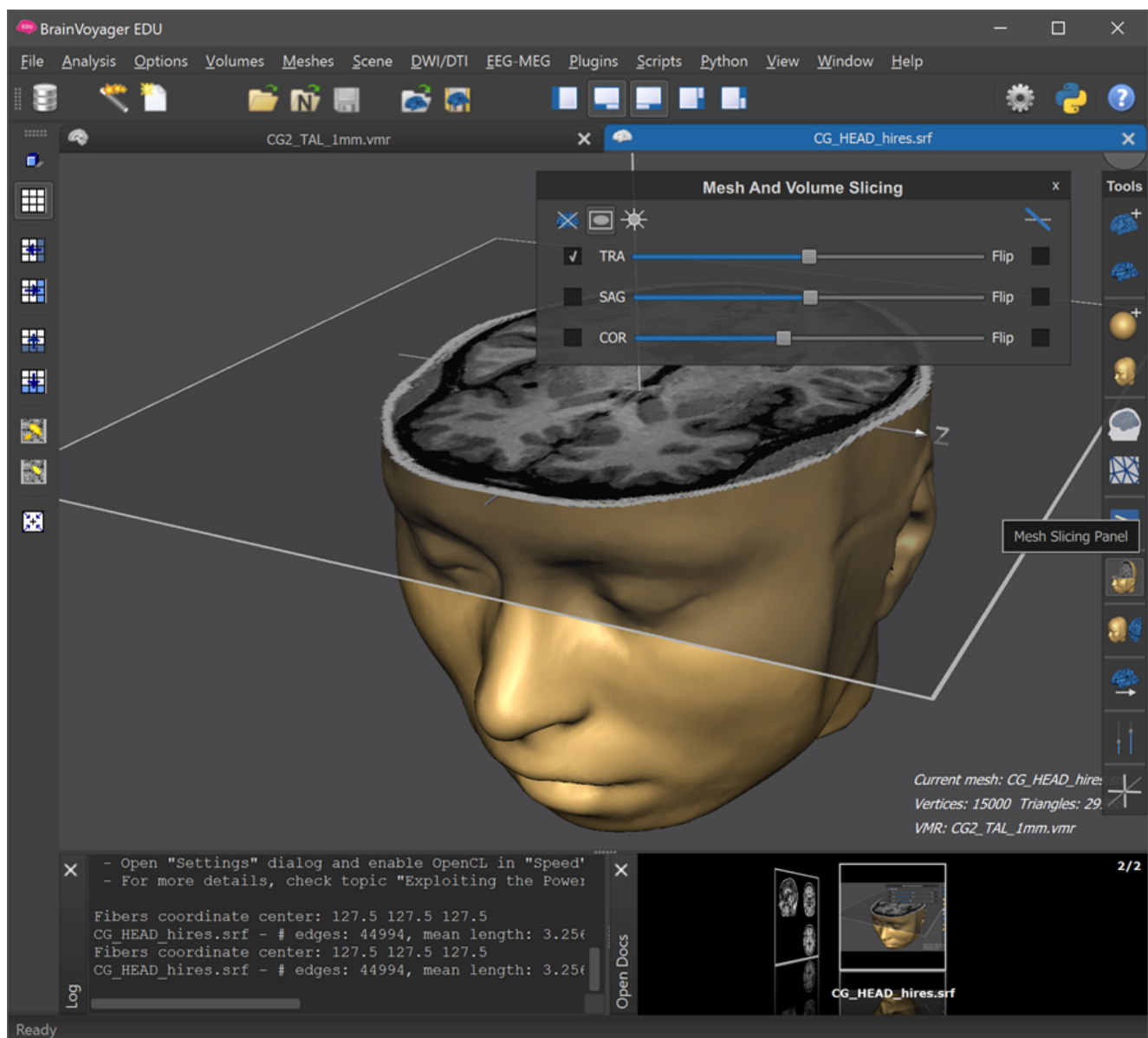
The **3D Viewer** has a **Mesh Toolbar** shown on the right edge, which allows to access major functions of the viewer. The toolbar can be freely moved around by clicking and holding its title bar. Its icons either launch a certain function or show a panel for controlling parameters of a specific function. Hovering the mouse over an icon reveals a tooltip briefly describing the respective function. One such panel is the **Viewpoint Navigation** panel that can be invoked by clicking the second last icon in the toolbar (see below).



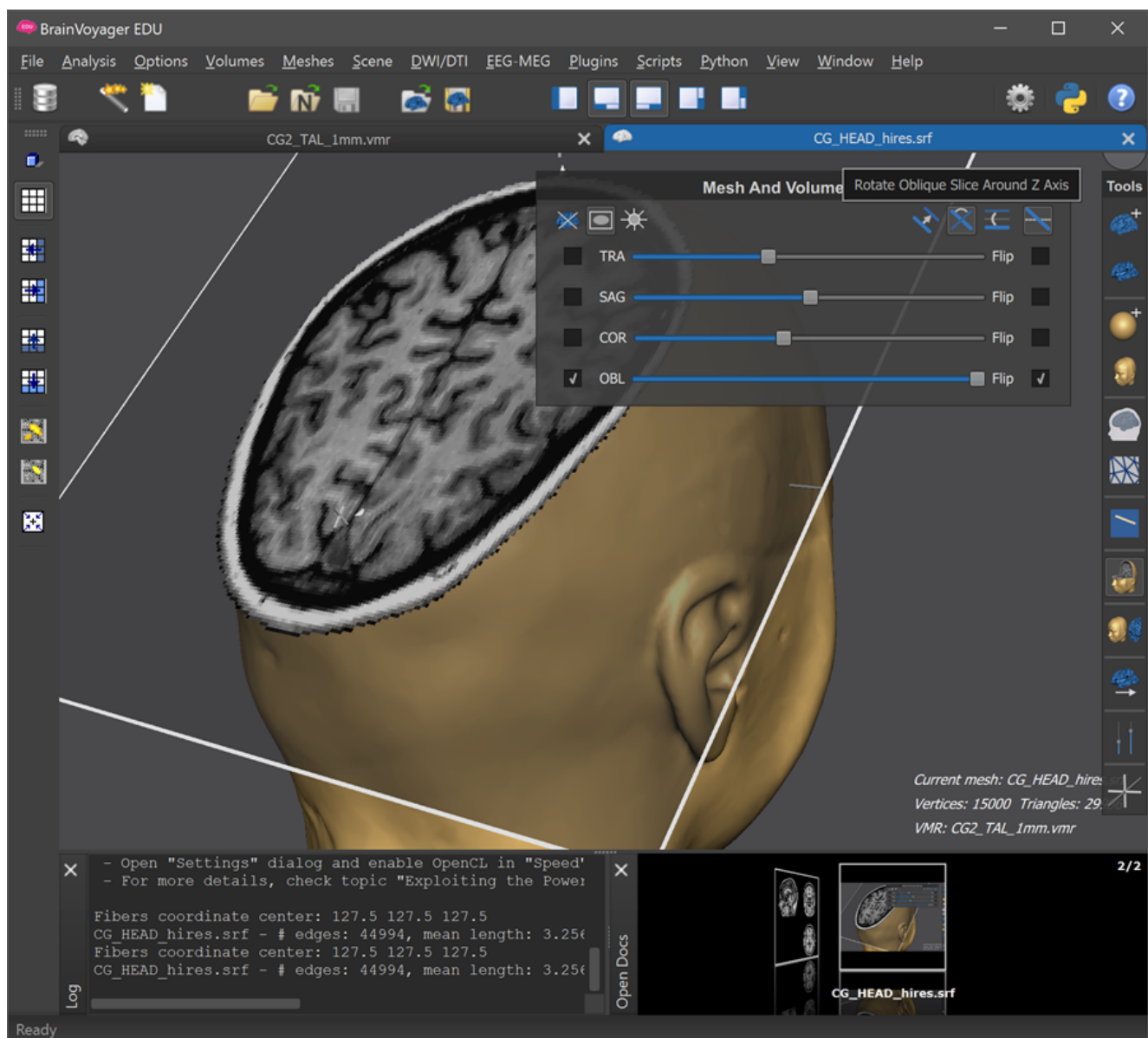
Besides using the mouse to rotate and move the mesh (i.e. stage), you can also use the sliders of the **Viewpoint Navigation** panel. In order to set the viewpoint to a canonical view, you can also click on one of the brain icons on the left side of the panel.

Mesh Slicing

An important feature of the **3D Viewer** is the possibility to slice meshes along axial, coronal, sagittal and oblique planes. Slicing is controlled with the **Mesh And Volume Slicing** panel, which can be shown by clicking the **Mesh Slicing Panel** icon in the **Mesh Toolbar** (see screenshot below).

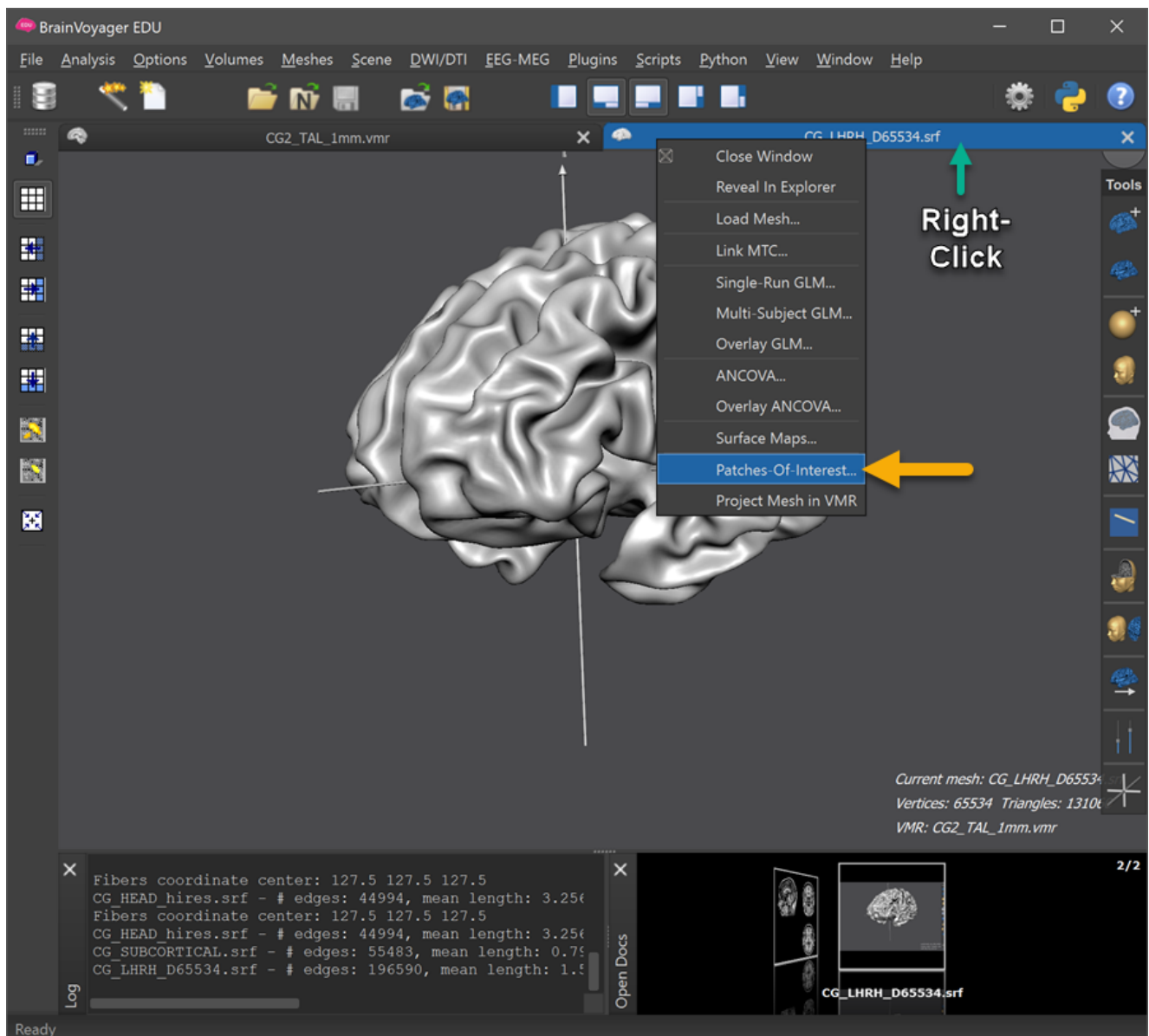


One or more slice planes can be enabled by checking the **TRA** , **SAG** and **COR** option boxes on the left side of the panel. Use the corresponding sliders to change the position at which the mesh will be sliced. Since the mesh is linked to the **CG2 TAL 1mm** VMR document, the slice planes are not empty but show the corresponding intensity information from that anatomical dataset. Note that you can use the **Flip** option boxes to specify which side of the mesh is cut away. In case you want an arbitrary oblique slice plane, select the **Oblique** icon in the right upper corner of the panel, which will reveal additional options to rotate and move the oblique plane (see below).

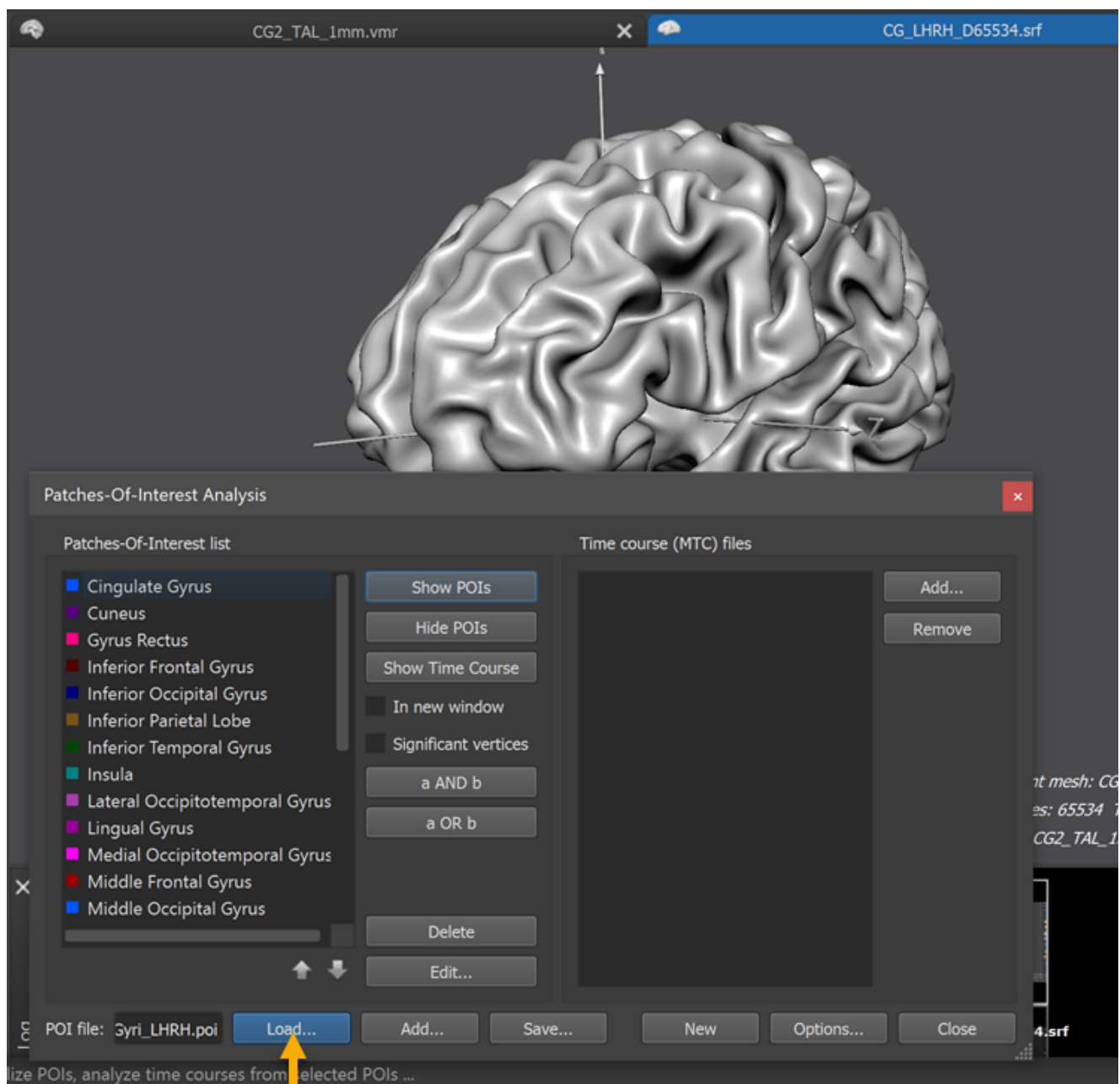


Patches-Of-Interest

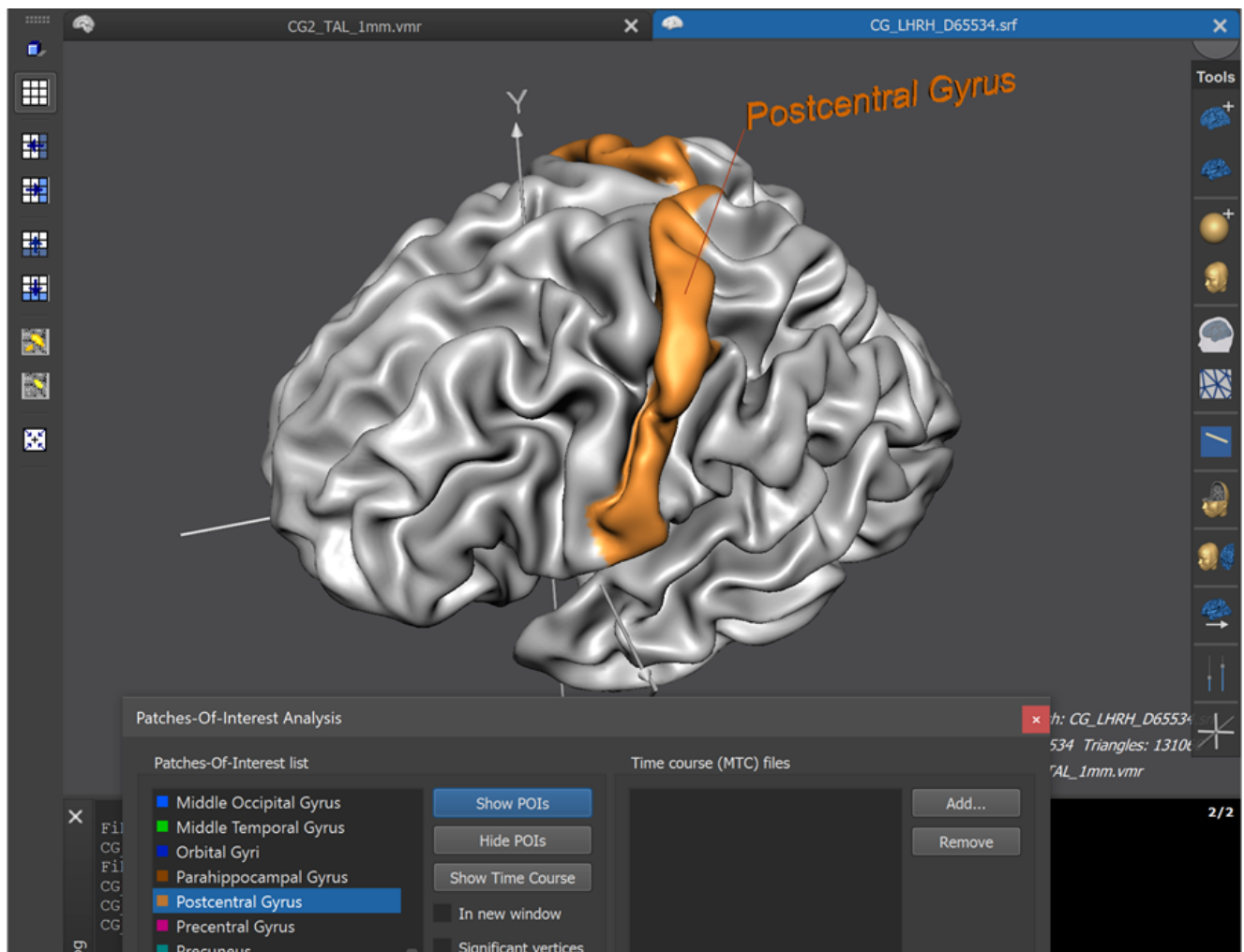
Now we open another mesh by clicking the **Load Mesh** icon and select the **CG_LHRH_D6354.srf** mesh in the **BrainTutorData** folder. This mesh contains the left and right hemisphere combined and has been prepared by reconstruction the white-grey matter boundary of the **CG2_TAL_1mm.vmr** document after running a segmentation process. You can use the previously described viewpoint navigation options to inspect the dataset. We now load regions-of-interest - called *patches of interest* or simply POIs if defined on a mesh surface, using the **Patches-Of-Interest** entry in the mesh window title bar menu that appears after right- (option-) clicking (see below).



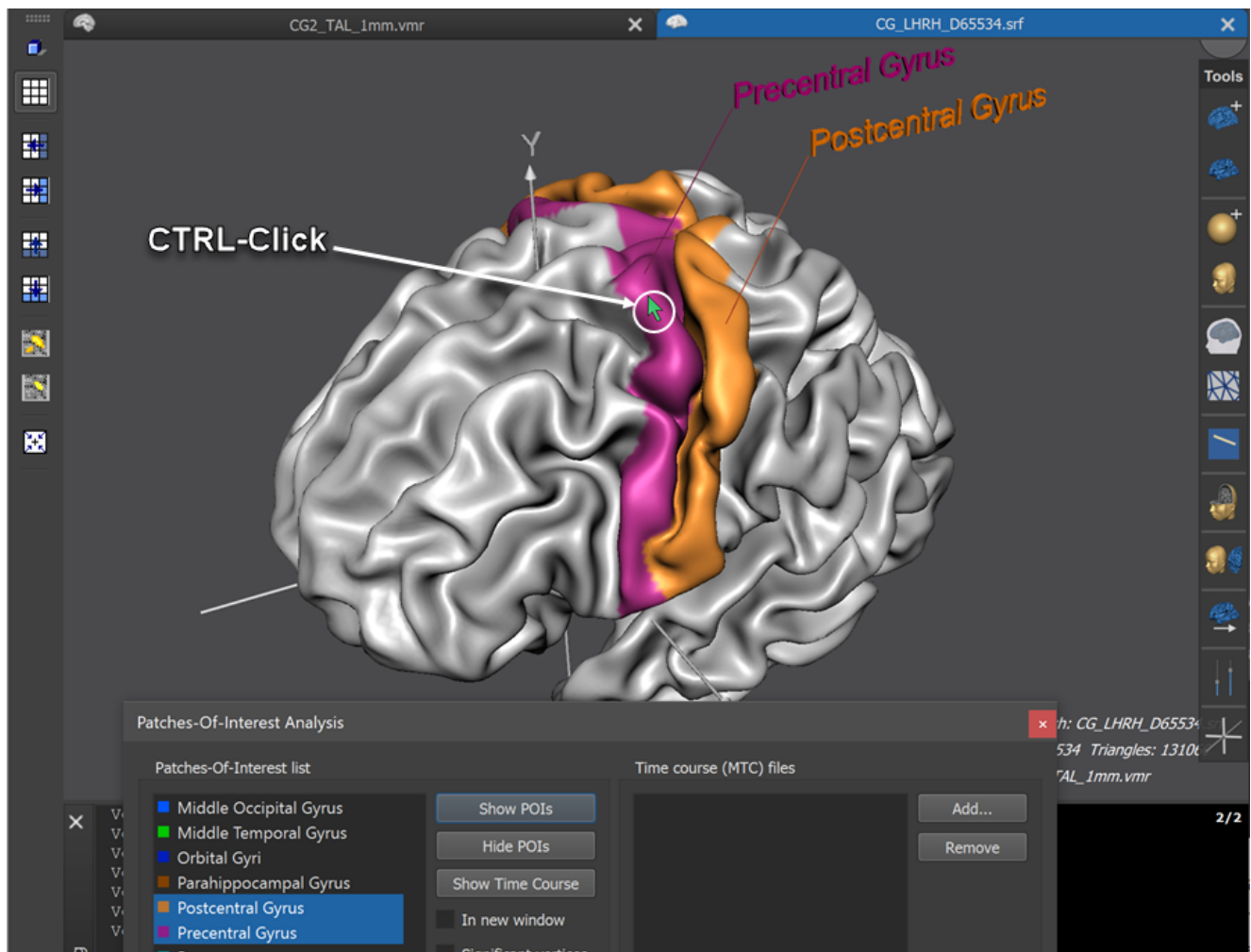
This will open the **Patches-Of-Interest Analysis** dialog (see below). In order to load a POI file, click the **Load** button in that dialog (see arrow below) and select the file **Gyri_LHRH.poi** in the **BrainTutorData** folder. As indicated below, the **Patches-Of-Interest list** will be filled with the names of POIs found in the loaded file, which are in our case the names of macroanatomical gyri.



You can now select one or more POIs in the list and click the **Show POIs** button to visualize the corresponding region on the cortex mesh. In the screenshot below, the 'Postcentral Gyrus' entry has been selected in the POIs list that was then visualized on the mesh after clicking the **Show POIs** button.

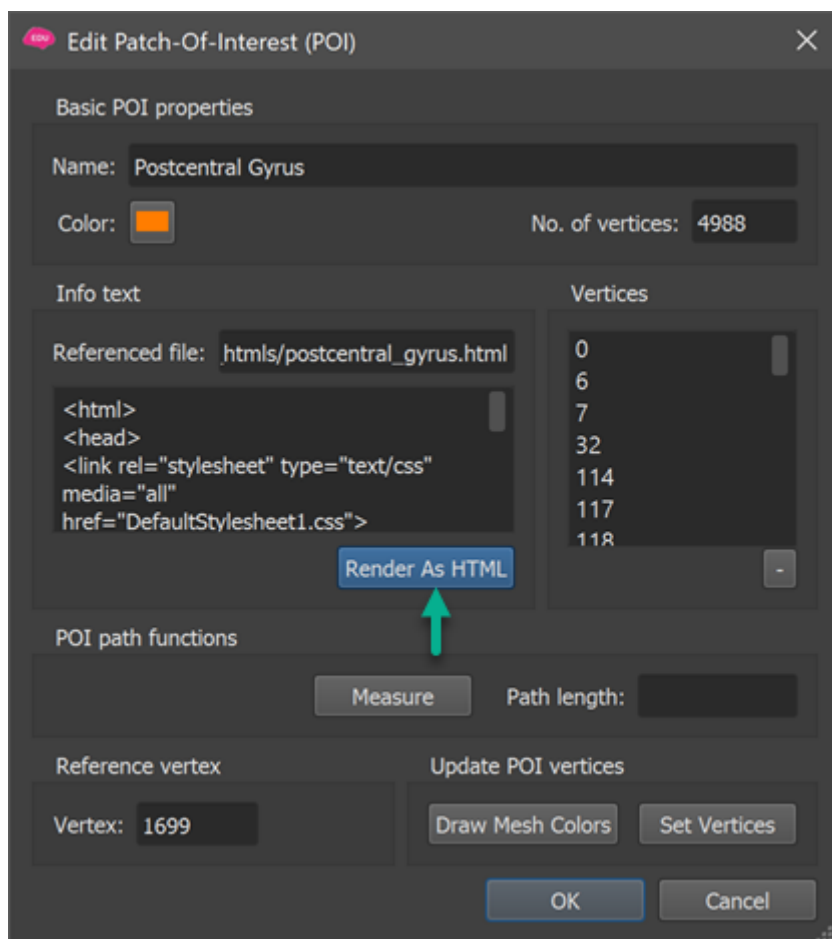


As you can see in the screenshot above, the corresponding gyrus is marked in a specific color. Furthermore a 3D text label is shown to indicate the respective POI. Another way to visualize POIs is by simply CTRL- (CMD-) clicking on the mesh itself - in case that the CTRL-clicked location (vertex position) is part of a POI definition, the region is highlighted in the same way as if that region would be selected in the POI list. *Note.* In order to have input focus, you may need to first left-click once in the mesh window before performing a CTRL-click

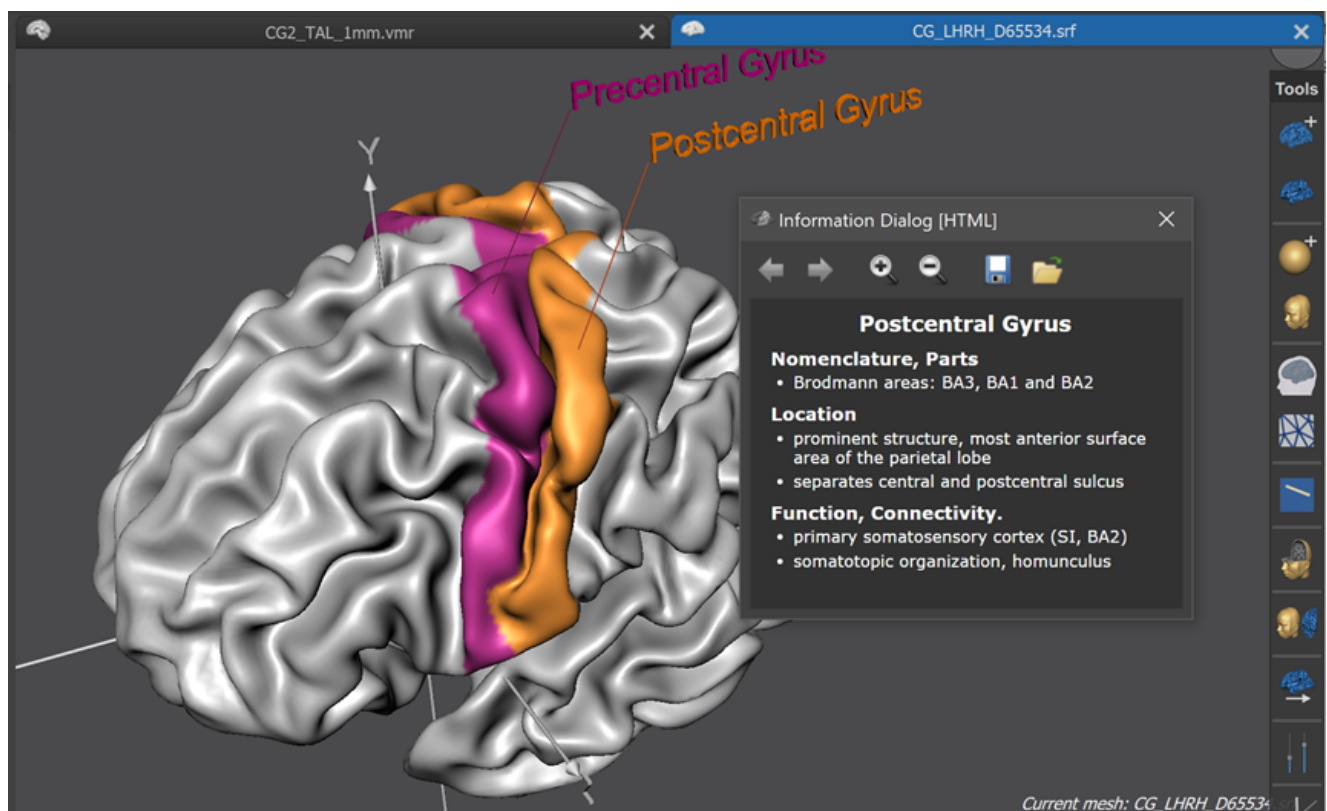


The screenshot above shows the state after a CTRL-click has been performed on a location belonging to the precentral gyrus, which was immediately marked as a whole in a predefined color. Furthermore the 3D text label 'Precentral Gyrus' has been shown and the corresponding entry in the POI list has been selected. In order to no longer show a selected POI, simply CTRL-click it again. You can also hide all POI color markings by clicking the **Hide POIs** button in the **Patches-Of-Interest Analysis** dialog.

As an exercise, go ahead and visualize other gyri. You can also load another POI file to visualize, for example, sulci or functional regions. You may also change the name and color of individual POIs using the **Edit** button in the **Patches-Of-Interest Analysis** dialog. The appearing **Edit Patch-Of-Interest** dialog (see below) contains basic properties of the selected POI such as its name, color and number of mesh vertices defining its region.



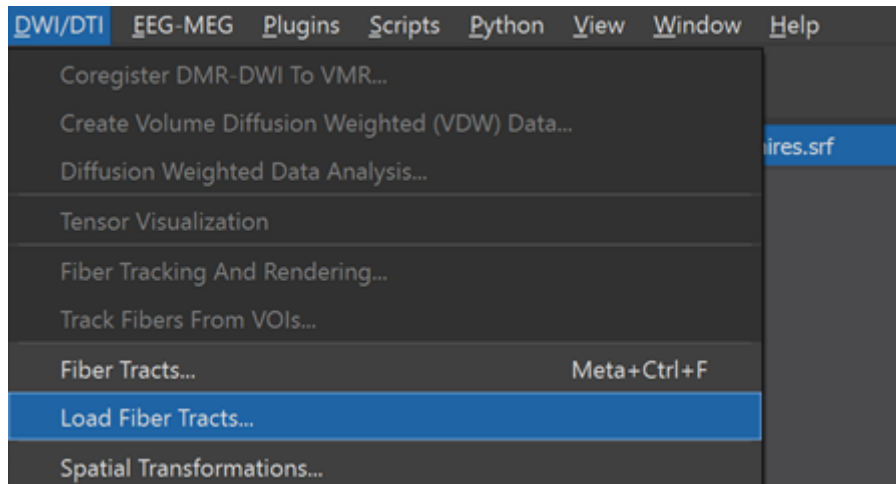
The Edit POI dialog also contains a (HTML) text field that contains descriptive information for the inspected POI that is retrieved from a referenced HTML file ('postcentral_gyrus.html' in the example above).. Clicking the `Render As HTML` button creates a rendered text view window that can be kept and placed next to the selected POI on the mesh after closing the dialog (see screenshot below).



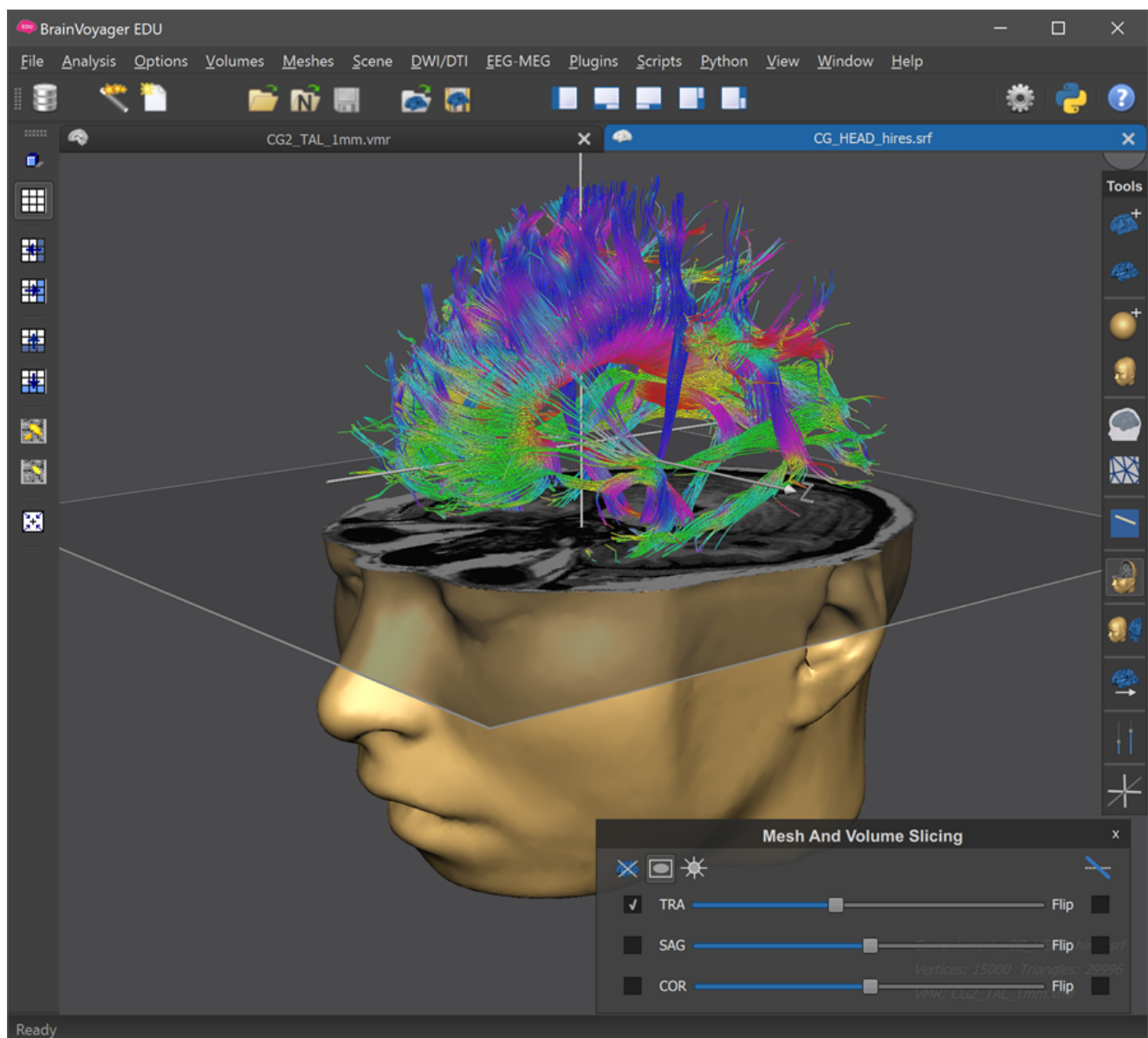
In a future update of this guide, we will also describe how you can define your own POIs.

Fiber Tracts

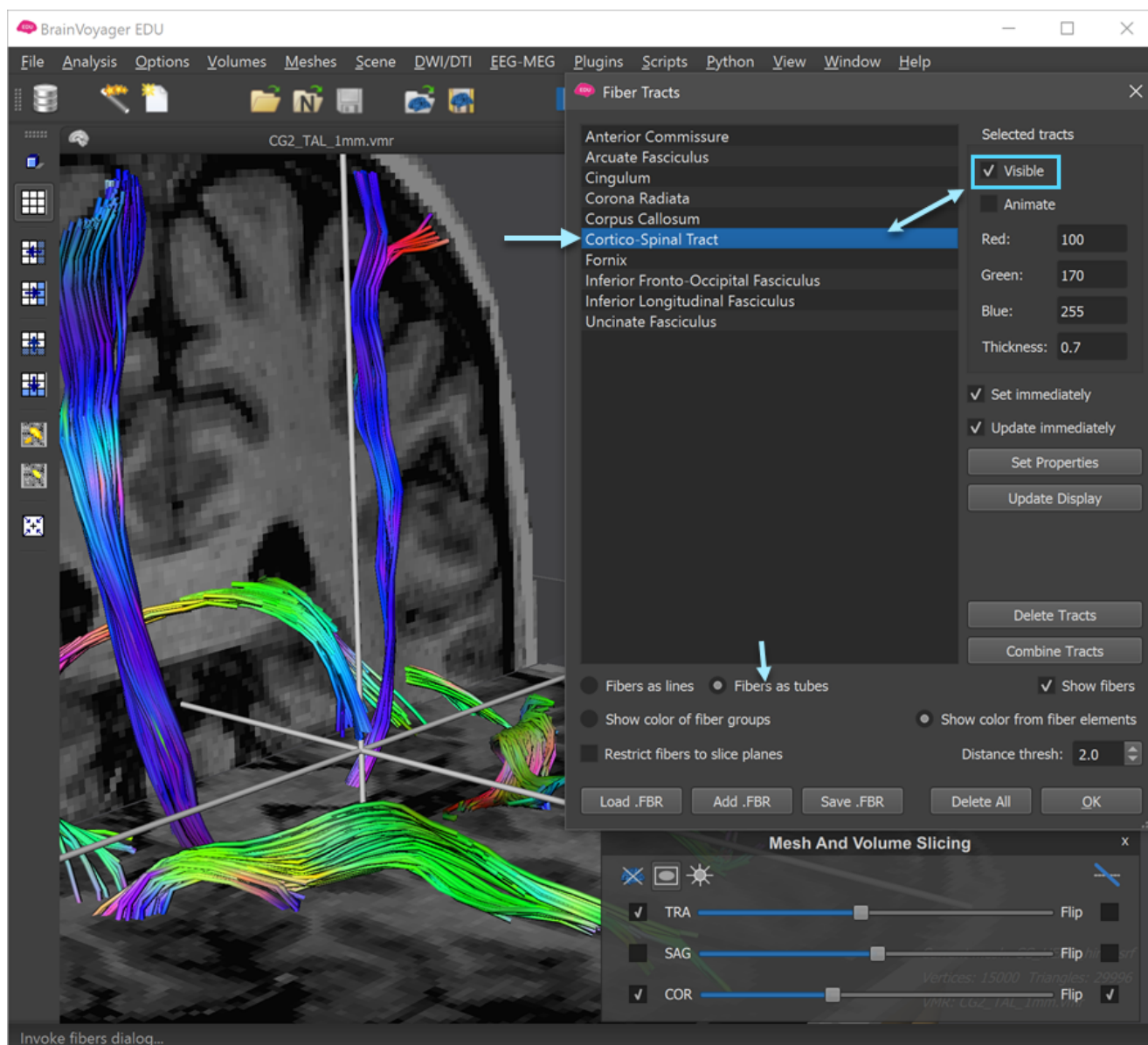
In this part of the tutorial we will learn how to load fiber tracts that have been prepared with BrainVoyager from diffusion weighted imaging MRI data. While the fiber tracts are reconstructed from an old DWI dataset that is no longer state of the art, it can be used to show some basic visualization options available in BrainVoyager.



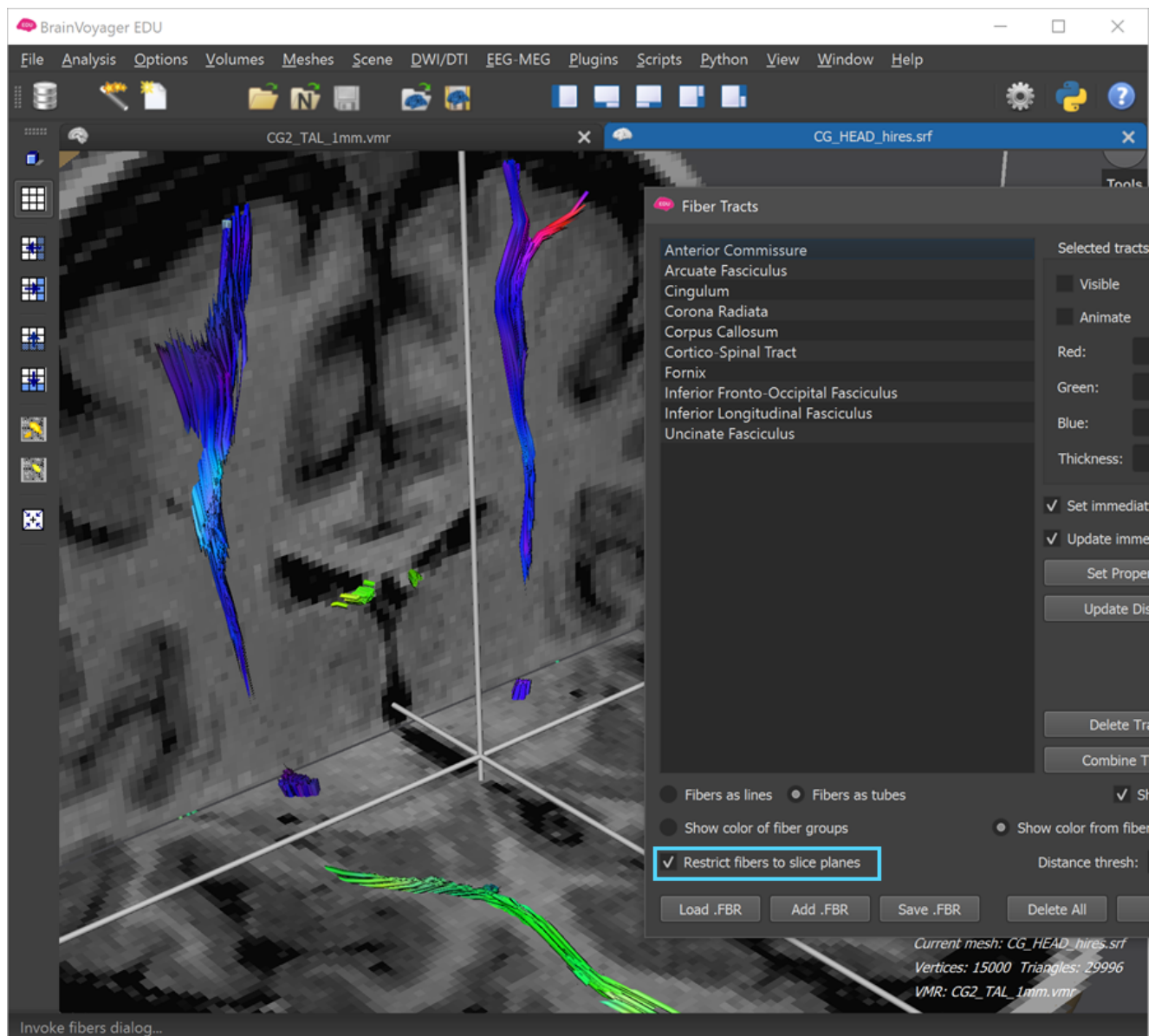
Load the head mesh by clicking the **Load Mesh** icon and select the CG head hires.srf file in the BrainTutorData folder. You may also load a brain mesh since for this part of the tutorial the mesh used is not critical as long as it is in the same reference space than the used fiber tracts (here Talairach space). Now slice the head mesh as described earlier, e.g. by selecting an axial cut plane. In order to load a fiber tract file, click the **Load Fiber Tracts** item in the **DWI/DTI** menu and select the **FiberTracts_v1_HP3HF2_Release.fbr** file in the **BrainTutorData** folder. After loading the file, all fiber tracts are shown in the **3D Viewer** (see below) in the respective reference (here Talairach) space.



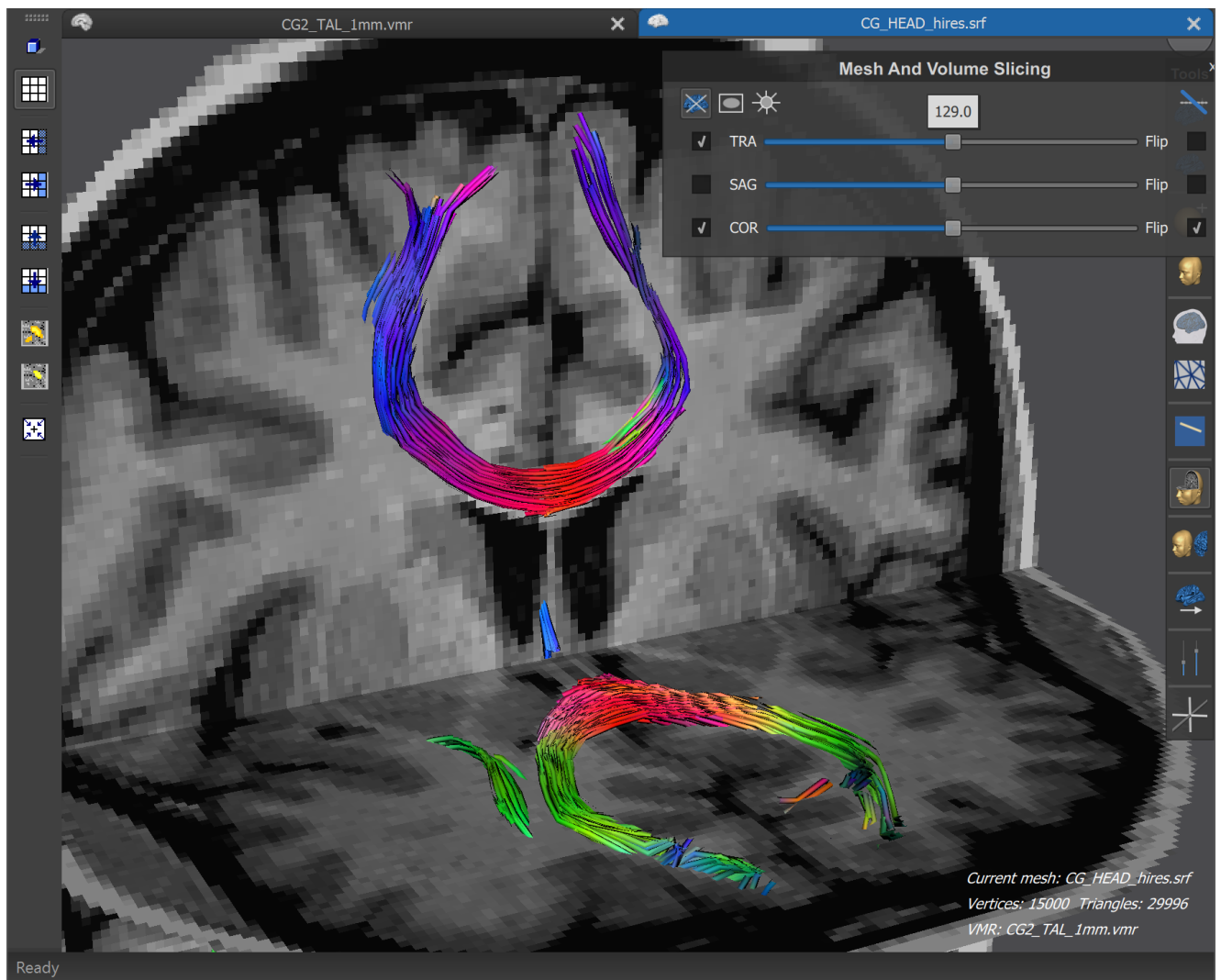
In order to select which fiber tracts should be shown and which should be hidden, enter the **Fiber Tracts** dialog that can be invoked by clicking the **Fiber Tracts** item in the **DWI/DTI** menu. The dialog shows a list of fiber tract names on the left upper side and options on the right side that can be changed for each item. The screenshot below shows that the **Visible** option has been checked for the 'Cortico-Spinal Tract' entry while it has been unchecked for most other tracts.



The **3D Viewer** now shows only the few selected fiber tracts. Note that the tracts are initially shown as simple line drawings; in order to show them as tubes with an adjustable thickness, select the **Fibers as tubes** option in the lower part of the dialog (see above). With this option in place, the thickness of the individual tubes can be adjusted using the **Thickness** text field. Note that you can change a fiber tract property for more than once tract at once by selecting multiple entries in the tracts list; to select all fibers quickly use the CTRL-A shortcut key.



A useful option to highlight how fibers relate to the underlying anatomy is to visualize fibers only if they are close to the currently specified slice planes. To enable this option, check the **Restrict fibers to slice planes** option in the **Fiber Tracts** dialog. The distance to the slice plan in which fibers are drawn can be adjusted using the **Distance thresh** number field. The screenshot above shows the effect of this option for the selected fiber tracts including the 'Cortico Spinal Tract' and the 'Inferior Longitudinal Fasciculus'. It is instructive to change the slice position of planes using the sliders of the **Mesh and Volume Slicing** panel. In the screenshot below, for example, the 'Corpus Callosum' tract is made visible and the coronal and axial slice planes are dynamically changed to highlight how the 'Corpus Callosum' runs through white matter.



Copyright © 2020 Rainer Goebel. All rights reserved.